Claims

What is claimed is:

1. A method of producing an electrode of a polymer electrolyte membrane type fuel cell comprising a polymer electrolyte membrane, an electrode contacting the polymer electrolyte membrane and including a gas diffusion layer and a catalyst layer provided in contact with the polymer electrolyte membrane, and a separator provided in contact with the gas diffusion layer, said method comprising:

(a) providing a polymer film;

(b) providing a gas diffusion layer;

(c) providing a paste including at least a carbon powder having a catalyst supported thereon mixed in a solvent,

(d) spreading said paste over said polymer film to provide a coated support,

(e) drying the coated support to evaporate said solvent to form a catalyst layer on said support,

(f) layering said gas diffusion layer and said catalyst layer with one another to form an electrode; and

(g) controlling a cracking occupation area on the electrode to a predetermined tolerance by controlling at least one of (a) a thickness of said catalyst layer formed in step (e), (b) a kind of carbon in said carbon powder having the catalyst supported thereon, and (c) a drying rate of said coated support in step (e).

2. The method according to claim 1, wherein said tolerance of the cracking occupation area is not greater than about 25%.

3. The method according to claim 1, wherein said thickness is controlled to be from about 10 μm to about 25 μm, the kind of carbon having the catalyst supported thereon is carbon having from about 5 wt% to about 20 wt% of platinum supported thereon, and the drying rate of the solvent is from about 2.5 $mg/cm^2 \cdot min$ to about 20 $mg/cm^2 \cdot min$.

4. The method according to claim 1, wherein the drying rate of the solvent is adjusted by controlling at least one of the kind of solvent and a drying temperature.

5. The method according to claim 1, wherein the polymer electrolyte membrane type fuel cell is used as a household fuel cell.

6. The method according to claim 1, wherein said catalyst is a noble metal catalyst.

7. The method according to claim 1, wherein said carbon powder is finely divided.

8. A method of producing an electrode of a polymer electrolyte membrane type fuel cell comprising a polymer electrolyte membrane, an electrode contacting the polymer electrolyte membrane and including a gas diffusion layer and a catalyst layer provided in contact with the polymer electrolyte membrane, and a separator provided in contact with the gas diffusion layer, said method comprising:

(a) providing a gas diffusion layer;

(b) providing a paste including at least a carbon powder having a catalyst supported thereon mixed in a solvent,

(c) spreading said paste over said gas diffusion layer,

(d) drying the paste and gas diffusion layer to evaporate said solvent to form said electrode comprising a catalyst layer on said gas diffusion layer, and

(e) controlling a cracking occupation area on the electrode to a predetermined tolerance by controlling at least one of (a) a thickness of said catalyst layer formed in step (d), (b) a kind of carbon in said carbon powder having the catalyst supported thereon, and (c) a drying rate in step (d).

9. The method according to claim 8, wherein said tolerance of the cracking occupation area is not greater than 25%.

10. The method according to claim 8, wherein said thickness is controlled to be from about 10 μm to about 25 μm,

the kind of carbon having the catalyst supported thereon is carbon having from about 5 wt% to about 20 wt% of platinum supported thereon, and the drying rate of the solvent is from about 2.5 $mg/cm^2 \cdot min$ to about 20 $mg/cm^2 \cdot min$.

11. The method according to claim 8, wherein the drying rate of the solvent is adjusted by controlling at least one of the kind of solvent and a drying temperature.

12. The method according to claim 8, wherein the polymer electrolyte membrane type fuel cell is used as a household fuel cell.

13. The method according to claim 8, wherein said catalyst is a noble metal catalyst.

14. The method according to claim 8, wherein said carbon powder is finely divided.

15. A method of producing an electrode of a polymer electrolyte membrane type fuel cell comprising a polymer electrolyte membrane, an electrode contacting the polymer electrolyte membrane and including a gas diffusion layer and a catalyst layer provided in contact with the polymer electrolyte membrane, and a separator provided in contact with the gas diffusion layer, said method comprising:

(a) providing a polymer film;

(b) providing a gas diffusion layer;

(c) providing a paste including at least a carbon powder having a catalyst supported thereon mixed in a solvent,

(d) spreading said paste over said polymer film to provide a coated support,

(e) drying the coated support to evaporate said solvent to form a catalyst layer on said support,

(f) layering said gas diffusion layer and said catalyst layer with one another to from an electrode; and

(g) controlling a volume resistivity of the catalyst layer to a predetermined tolerance by controlling at least one of (a) a thickness of said catalyst layer formed in step (e), (b) a kind of carbon in said carbon powder having the catalyst supported thereon, and (c) a drying rate of said coated support in step (e).

16. The method according to claim 15, wherein the tolerance of the volume resistivity is not greater than about 100 $\Omega \cdot cm$.

17. The method according to claim 15, wherein said thickness is controlled to be from about 10 μm to about 25 μm, the kind of carbon having the catalyst supported thereon is carbon having from about 5 wt% to about 20 wt% of platinum

supported thereon, and the drying rate of the solvent is from about 2.5 $mg/cm^2 \cdot min$ to about 20 $mg/cm^2 \cdot min$.

18. The method according to claim 15, wherein the ratio of the volume resistivity of the catalyst layer to the volume resistivity of the gas diffusion layer is not greater than about 10^7.

19. The method according to claim 15, wherein the drying rate of the solvent is adjusted by controlling at least one of the kind of solvent and a drying temperature.

20. The method according to claim 15, wherein the polymer electrolyte membrane type fuel cell is used as a household fuel cell.

21. A method of producing an electrode of a polymer electrolyte membrane type fuel cell comprising a polymer electrolyte membrane, an electrode contacting the polymer electrolyte membrane and including a gas diffusion layer and a catalyst layer provided in contact with the polymer electrolyte membrane, and a separator provided in contact with the gas diffusion layer, said method comprising:

(a) providing a gas diffusion layer;

(b) providing a paste including at least a carbon powder having a catalyst supported thereon mixed in a solvent,

(c) spreading said paste over said gas diffusion layer,

(d) drying the paste and gas diffusion layer to evaporate said solvent to form said electrode comprising a catalyst layer on said gas diffusion layer, and

(e) controlling a volume resistivity of the catalyst layer to a predetermined tolerance by controlling at least one of (a) a thickness of said catalyst layer formed in step (d), (b) a kind of carbon in said carbon powder having the catalyst supported thereon, and (c) a drying rate of said coated support in step (d).

22. The method according to claim 21, wherein the tolerance of the volume resistivity is not greater than about 100 Ω·cm.

23. The method according to claim 21, wherein said thickness is controlled to be from about 10 μm to about 25 μm, the kind of carbon having the catalyst supported thereon is carbon having from about 5 wt% to about 20 wt% of platinum supported thereon, and the drying rate of the solvent is from about 2.5 $mg/cm^2 \cdot min$ to about 20 $mg/cm^2 \cdot min$.

24. The method according to claim 21, wherein the ratio of the volume resistivity of the catalyst layer to the volume resistivity of the gas diffusion layer is not greater than about 10^7.

25. The method according to claim 21, wherein the drying rate of the solvent is adjusted by controlling at least one of the kind of solvent and a drying temperature.

26. The method according to claim 21, wherein the polymer electrolyte membrane type fuel cell is used as a household fuel cell.

27. A polymer electrolyte membrane type fuel cell, comprising:

a polymer electrolyte membrane,

an electrode including a gas diffusion layer and a catalyst layer provided in contact with the polymer electrolyte membrane, and

a separator provided in contact with the gas diffusion layer,

wherein a cracking occupation area on the electrode is not greater than about 25%.

28. The fuel cell according to claim 27, wherein a ratio of the volume resistivity of the catalyst layer to a volume resistivity of the gas diffusion layer is not greater than about 10^7.

29. A polymer electrolyte membrane type fuel cell, comprising:

a polymer electrolyte membrane,

an electrode including a gas diffusion layer and a catalyst layer provided in contact with the polymer electrolyte membrane, and

a separator provided in contact with the gas diffusion layer,

wherein a volume resistivity of the catalyst layer is not greater than about 100 Ω·cm.

30. The fuel cell according to claim 29, wherein a ratio of the volume resistivity of the catalyst layer to a volume resistivity of the gas diffusion layer is not greater than about 10^7.

31. A method of producing a catalyst layer for a fuel cell electrode, comprising:

mixing a catalyst-supporting carbon powder with a catalyst in a weight ratio of catalyst to carbon powder within the range of about 5% to about 20%;

dissolving the mixture of carbon powder and catalyst in a solvent to produce a solution;

applying the solution to a support; and

drying the applied solution.

32. The method of claim 31, wherein the solution is applied and dried to produce a dried catalyst layer having a thickness within the range of about 10 µm to about 25 µm.

33. The method of claim 31, wherein the applied solution is dried at a drying rate within the range of about 2.5 $mg/cm^2 \cdot min$ to about 50 $mg/cm^2 \cdot min$.

34. The method of claim 32, wherein the applied solution is dried at a drying rate within the range of about 2.5 $mg/cm^2 \cdot min$ to about 50 $mg/cm^2 \cdot min$.

35. A method of producing a catalyst layer for a fuel cell electrode, comprising:

mixing a catalyst-supporting carbon powder with a catalyst;

dissolving the mixture of carbon powder and catalyst in a solvent to produce a solution;

applying the solution to a support and drying the applied solution to produce a dried catalyst layer having a thickness within the range of about 10 µm to about 25 µm.

36. The method of claim 35, wherein the applied solution is dried at a drying rate within the range of about 2.5 $mg/cm^2 \cdot min$ to about 50 $mg/cm^2 \cdot min$.

37. A method of producing a catalyst layer for a fuel cell electrode, comprising:

mixing a catalyst-supporting carbon powder with a catalyst;

dissolving the mixture of carbon powder and catalyst in a solvent to produce a solution;

applying the solution to a support; and

drying the applied solution at a drying rate within the range of about 2.5 $mg/cm^2 \cdot min$ to about 50 $mg/cm^2 \cdot min$.

38. An electrode for a fuel cell, comprising:

a support; and

a catalyst layer, disposed on the support, comprising a catalyst-supporting carbon powder and a catalyst in a weight ratio of catalyst to carbon powder within the range of about 5% to about 20%.

39. The electrode of claim 38, wherein the catalyst layer has a thickness within the range of about 10 µm to about 25 µm.

40. The electrode of claim 38, wherein:

the catalyst layer is produced by:

mixing the catalyst-supporting carbon powder with the catalyst,

dissolving the mixture of carbon powder and catalyst

in a solvent to produce a solution,

applying the solution to the support, and

drying the applied solution at a drying rate within the range of about 2.5 $mg/cm^2{\cdot}min$ to about 50 $mg/cm^2{\cdot}min$; and

the catalyst layer has a volume resistivity that is no greater than about 20 ohms·cm.

41. The electrode of claim 39, wherein:

the catalyst layer is produced by:

mixing the catalyst-supporting carbon powder with the catalyst,

dissolving the mixture of carbon powder and catalyst in a solvent to produce a solution,

applying the solution to the support, and

drying the applied solution at a drying rate within the range of about 2.5 $mg/cm^2{\cdot}min$ to about 50 $mg/cm^2{\cdot}min$; and

the catalyst layer has a volume resistivity that is no greater than about 20 ohms·cm.

42. The electrode of claim 38, wherein:

the catalyst layer is produced by:

mixing the catalyst-supporting carbon powder with the catalyst,

dissolving the mixture of carbon powder and catalyst

in a solvent to produce a solution,

applying the solution to the support, and

drying the applied solution at a drying rate within the range of about 2.5 $mg/cm^2 \cdot min$ to about 50 $mg/cm^2 \cdot min$; and

the catalyst layer has a cracking occupation area ratio that is no greater than about 25 percent.

43. The electrode of claim 39, wherein:

the catalyst layer is produced by:

mixing the catalyst-supporting carbon powder with the catalyst,

dissolving the mixture of carbon powder and catalyst in a solvent to produce a solution,

applying the solution to the support, and

drying the applied solution at a drying rate within the range of about 2.5 $mg/cm^2 \cdot min$ to about 50 $mg/cm^2 \cdot min$; and

the catalyst layer has a cracking occupation area ratio that is no greater than about 25 percent.

44. The electrode of claim 40, wherein the catalyst layer has a cracking occupation area ratio that is no greater than about 25 percent.

45. The electrode of claim 41, wherein the catalyst layer has a cracking occupation area ratio that is no greater than about 25 percent.

46. An electrode for a fuel cell, comprising:

a support; and

a catalyst layer, disposed on the support, having a thickness within the range of about 10 μm to about 25 μm.

47. The electrode of claim 46, wherein:

the catalyst layer is produced by:

mixing a catalyst-supporting carbon powder with a catalyst,

dissolving the mixture of carbon powder and catalyst in a solvent to produce a solution,

applying the solution to the support, and

drying the applied solution at a drying rate within the range of about 2.5 $mg/cm^2 \cdot min$ to about 50 $mg/cm^2 \cdot min$; and

the catalyst layer has a volume resistivity that is no greater than about 20 ohms·cm.

48. The electrode of claim 46, wherein:

the catalyst layer is produced by:

mixing a catalyst-supporting carbon powder with a catalyst,

dissolving the mixture of carbon powder and catalyst in a solvent to produce a solution,

applying the solution to the support, and

drying the applied solution at a drying rate within the range of about 2.5 $mg/cm^2 \cdot min$ to about 50 $mg/cm^2 \cdot min$; and

the catalyst layer has a cracking occupation area ratio that is no greater than 25 percent.

49. The electrode of claim 47, wherein the catalyst layer has a cracking occupation area ratio that is no greater than about 25 percent.

50. An electrode for a fuel cell, comprising:

a support; and

a catalyst layer disposed on the support, wherein:

the catalyst layer is produced by:

mixing a catalyst-supporting carbon powder with a catalyst,

dissolving the mixture of carbon powder and catalyst in a solvent to produce a solution,

applying the solution to the support, and

drying the applied solution at a drying rate within the range of about 2.5 $mg/cm^2 \cdot min$ to about 50 $mg/cm^2 \cdot min$; and

the catalyst layer has a volume resistivity that is no

greater than about 20 ohms·cm.

51. The electrode of claim 50, wherein the catalyst layer has a cracking occupation area ratio that is no greater than about 25 percent.

52. An electrode for a fuel cell, comprising:

a support; and

a catalyst layer disposed on the support, wherein:

the catalyst layer is produced by:

mixing a catalyst-supporting carbon powder with a catalyst,

dissolving the mixture of carbon powder and catalyst in a solvent to produce a solution,

applying the solution to the support, and

drying the applied solution at a drying rate within the range of about 2.5 $mg/cm^2 \cdot min$ to about 50 $mg/cm^2 \cdot min$; and

the catalyst layer has a cracking occupation area ratio that is no greater than about 25 percent.